A Fast Switching Mirror Unit at FLASH.

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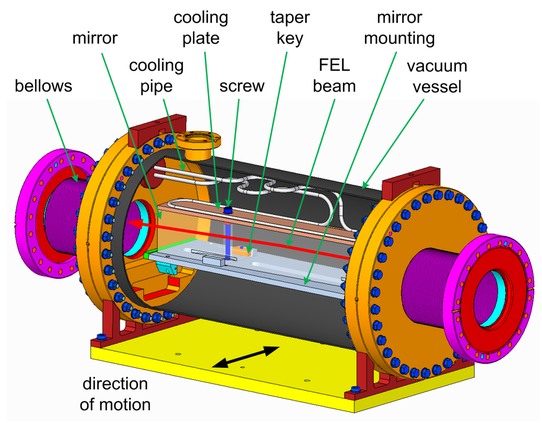
Introduction

At the “Free Electron Laser Hamburg” (FLASH) the created laser light is diverted towards different test sites by massive silicon mirrors, of which one can be operated in permanent switching mode. In order to match the native FLASH frequency of 10 Hz, the aim is to achieve a switching frequency of 5 Hz. With the initial concept, where the mirror was moved together with the vacuum vessel by a linear drive, a maximum switching frequency of 2.5 Hz was attained with the required precision. Therefore new concepts for the switching process are being developed, putting the focus on reducing the translational inertia in order to increase the switching frequency.

Initial motion Concept: Motion of mirror and vessel with a linear drive

3-dimensional CAD model

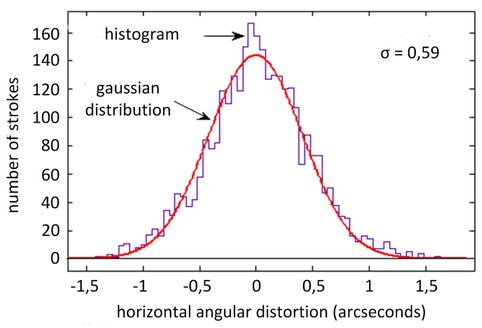


Comparison: Steel vs. Titanium Vessel

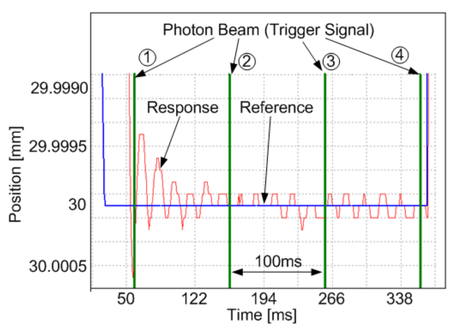
Vessel material	Steel	Titanium
mass (kg)	> 60	ca. 37
Maximum switching frequency f_{max}	2,5 Hz	5,0 Hz
Bellow replacement interval at f_{max}	46 days	23 days

Measurements: Steel Vessel

Horizontal angular distortion

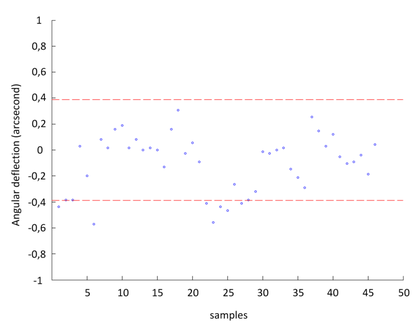


Positional misalignment



Measurements: Titanium Vessel

Horizontal angular distortion

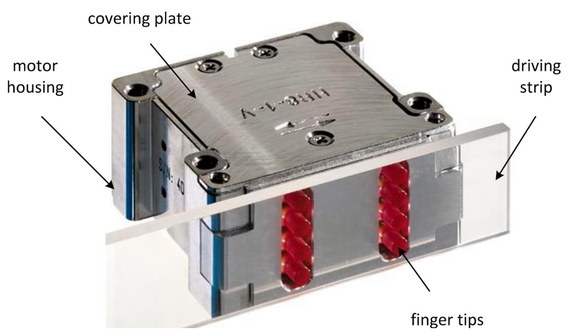


Conclusions

- Strong vibrations during the switching process with f = 5 Hz
- Frequent bellow replacement necessary (23 days at f = 5 Hz)
- Motion of the mirror inside the vacuum preferential!

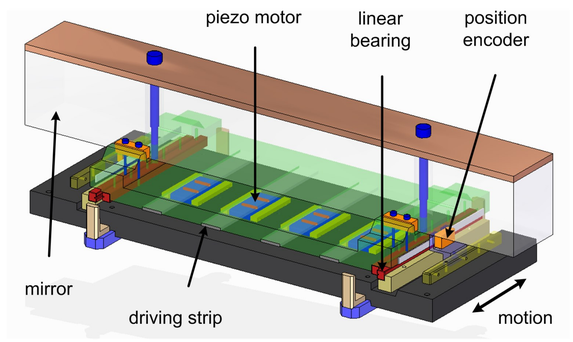
UHV-motion with piezo motors

Piezo motor Nanomotion HR8



Number of finger tips	8
Maximum driving force	32 N
Maximum speed	250 mm/s
Heat generation	2 Watts
Baking temperature	140°C

Test setup

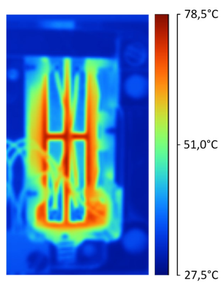


Mass of the assembly	ca. 10 kg
Number of motors	4
Driving force / motor	25 N
Speed limit	50 mm/s

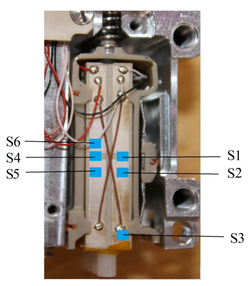
→ Too slow to use it as drive unit for the switching mirror !

Temperature measurements

Thermal image of HR8-Motor



PT100 sensor positions

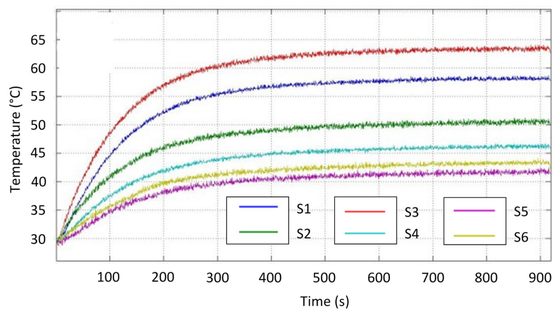


Measurement conditions

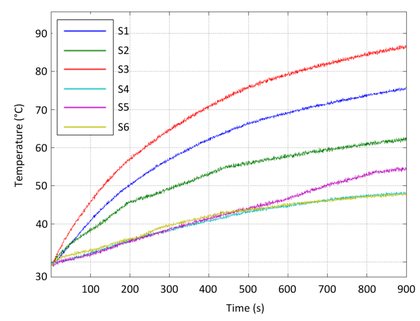
Duration	15 minutes
Maximum speed	100 mm/s
Stroke	30 mm

Temperature measurements

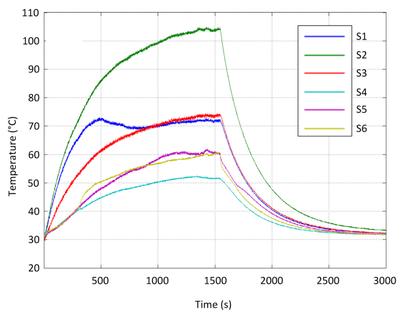
P = 1000 mbar



P = 10^{-4} mbar



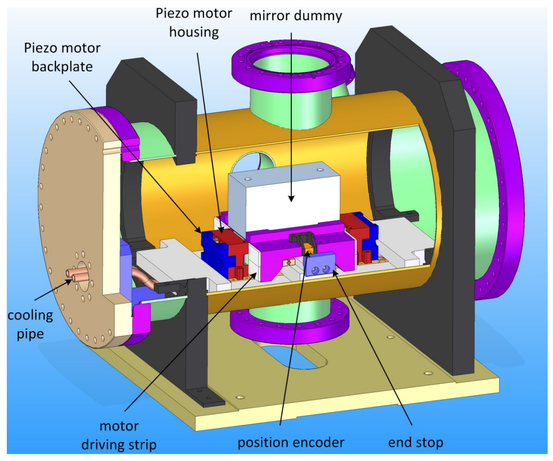
P = 10^{-4} mbar (mounted covering plate)



Conclusions

- 25%-30% increased temperatures in vacuum (max. 85°C)
- Extra 25% increased temperatures with mounted covering plate (105°C)
- Stable plateau not reached after 15 minutes

Proposed temperature test setup



- Development of a new piezo motor housing
- Provisions for water cooling
- Possibility to test both old and new motor housing

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